FIELD TRIP GUIDEBOOK
CORTLAND AREA

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Contents

GLACIAL GEOLOGY AND GEOMORPHOLOGY BETWEEN CORTLAND AND SYRACUSE

Ernest H. Muller, Syracuse University

General statement

The Cortland-Syracuse area is characterized by landscapes that record a compound and multicyclic origin, although glaciation effaced all but a shadowy "memory" of pre-glacial topography. The approach to accordance of plateau summits and the initiating controls on the pattern of through valley development are recognized as being of pre-glacial origin. The through valley system consists of a transecting network of "intrusive troughs" in the sense of Linton (1963), initiated by, but largely over-riding the inherited control of pre-glacial drainage pattern. The area lies largely within "through valley zone B" of Clayton (1965), characterized by particularly prominent entrenching of the through valley system together with minimal reduction of the upland surface.

In view of the moderate to high relief of the plateau, it is to be expected that deglaciation as recorded by late Cary drift involved as much stagnation and downwasting as backwasting of an active ice margin. The glacial drift in through valleys aligned more or less parallel to principle directions of ice-flow is characterized by high proportions of pebbles of types foreign to the plateau. These pebbles, including dolomite, limestone, red sandstone and crystalline rocks, give such drift a "bright" appearance characteristic of "Binghamton drift" in the sense of a lithofacies rather than a fundamental stratigraphic unit (Denny, 1956; Merritt and Muller, 1959; Moss and Ritter, 1962).

In southward sloping valleys, deposits and features which represent former ice marginal positions tend to be numerous, ill-defined and too discontinuous for ready correlation and lateral tracing. By contrast, in near-divide positions and in valleys sloping toward the waning ice margin, bordering deposits and features are commonly massive and conspicuous. Of such nature is the Valley Heads moraine system which corresponds generally to the drainage divide between present St. Lawrence and Susquehanna River basins.

Environs of Cortland

Cortland is located on a gravel outwash plain at elevation of 1125 ft. in valleys cut into a plateau with summits more than 1800 ft. above sea level. Because lines of communication have historically developed along plateau valleys, Cortland occupies a particularly favorable site at the hub of five through valleys that converge like spokes from the north, northeast, east, south, and southwest. All five are occupied by streams of the Tioughnioga system, tributary to the Susquehanna River.

Discordance between stream discharge and valley dimensions shows that all five streams merely occupy inherited troughs and have had little influence on the development of valleys they occupy. The broadest of the troughs is that to the southwest occupied by tiny Otter Creek. East and West Branches of Tioughnioga River occupy valleys only slightly narrower, which open toward Cortland from the north and northeast, respectively. Trout Creek enters Tioughnioga River from the east in a valley which is more nearly proportioned to basin area than are the other valleys. Tioughnioga River carries the discharge of the other streams southward into a valley with walls that converge within 6 miles to enclose alluvial flats of little more than channel width. First pointed out by Fairchild (1925) this anomaly has been recognized as evidence of reversal of drainage across a pre-glacial divide (Asselstine, 1946; Durham, 1954; von Engeln, 1961).

Durham (1954, 1958) interpreted the through valley system in the Cortland area as representing modification of a pre-glacial system of tributaries to a southwestward draining trunk stream. He recognized a pre-glacial divide as lying approximately at the location of the Tully moraine of von Engeln (1921). Southward from this divide Durham traces a continuous long profile for the bedrock valley floor as identified in widely spaced wells, decreasing in elevation from about 1210 feet near Tully Center, to 900 ft. near Cortland and 855 ft.

near Freeville. The westward extension of this drift-filled valley is occupied by Fall Creek from McLean west to the Cayuga trough where it hangs several hundred feet above the floor of the trough (Tarr, 1904; Pollack, 1958).

Width of valley floor in the vicinity of Cortland is largely determined by the depth of valley fill. Asselstine (1946) summarizes well data near Cortland as recording deposition of two gravel units, each approximately 50 feet thick, separated by a 100-ft. thick unit of sand and silt. The intermediate unit presumably represents conditions of low gradient and restricted drainage south across the Tioughnioga col. The upper gravel relates to deposition of coarse outwash aggrading east-northeastward from the Valley Heads moraine just west of South Cortland. Maximum thickness of valley fill in the vicinity of Cortland is suggested by the fact that a well drilled to 185 ft. failed to reach bedrock at elevation of 915 feet in downtown Cortland, whereas a 300-ft. deep well in South Cortland entered bedrock at approximately 900 feet above sea level.

The campus of the State University College at Cortland stands upon an isolated bedrock hill, surrounded by valley fill and rising about 340 feet above the bedrock floor of the valley. This isolated knob or umlaufberg appears to be an extension of the ridge northeast of Cortland. Although the Tioughnioga River presently flows between the umlaufberg and ridge, the deepest part of the bedrock valley may indeed lie south of the isolated hill. The ridge and knob together appear to have separated convergent valleys cut by tributaries to a major southwestward draining ancestral stream. Concentrated glacial scour at the south end of the Tully-Cortland trough effected the reducing and isolating of the knob. Aggrading valley fill completed the separation of knob from upland. In similar fashion, continued aggradation of outwash to thickness of another 250 to 300 feet would isolate the next summit northeastward by covering the adjacent col at 1260 feet above sea level.

Upland surface

To ascertain the amount of summit modification and reduction due to glaciation is possible near the limit of graciation in southwestern New York where summit accordance in the unglaciated Salamanca re-entrant affords indication of the character of the pre-glacial upland surface (Muller, 1963). In the Cortland area, remote from unglaciated uplands of Pennsylvania it is far less valid to draw inferences as to the measure of summit reduction. The illusion of regularity and horizontality of horizon obtained from summits around Cortland is misleading. Even summit contours generalized to a six-mile grid give an impression of imperfect summit accordance.

Within each upland area bounded by the transection network of through valleys, the central summits rise approximately to 2000 feet above sea level. The highest elevation in the immediate vicinity of Cortland is about 2130 ft. in the Greek Peak area of the Virgil Hills. Although central summit elevations diminish slightly northward, Morgan Hill in southeastern Onondaga County exceeds 2060 feet above sea level. On this basis one is justified in visualizing for the Cortland area a pre-glacial upland surface of near accordance with weakly cuestaform zones of slightly higher summits associated with outcropping of relatively resistant strata. In relation to such widespread approach to pre-glacial accordance, one may argue that summit reduction ranges from very slight in the case of central summits which are rounded by perhaps essentially unreduced, to as much as several hundred feet of reduction of summits in more exposed positions.

Northwestward, furrowing of the upland by long sub-parallel depressions is progressively more marked. Shallow cols are characterized by catenary transverse profiles. Rounded summits are increasingly parallel and mean summit elevation diminishes. Relief between summits and adjacent troughs generally decreases northward. With diminishing relief the transection network of through valleys becomes less complex. Such are the changes toward the central Finger

Lakes which led Clayton (1965) to distinguish concentric zones of increasing intensity of glacial modification arrayed southeast, south and southwest around Cayuga-Senega basin.

The thickness of drift that mantles the uplands is generally much less and the lithology of pebble types is more strongly dominated by local rock than is the case for drift in through valleys. Defining as upland all locations more than 1300 feet above sea level, Carney (1909) determined average thickness of upland drift in 210 well records to be approximately 25 feet in the Moravia quadrangle, northwest of Cortland. Similarly, Coates (in press) has recently shown the average thickness of upland drift in the Binghamton area to be greater than commonly assumed.

Moraines

The Tully moraine (von Engeln, 1921) comprises the drainage divide and head of outwash in the Cortland-Homer-Tully trough. This massive, valley-stopping moraine is part of the Valley Heads moraine system which has been traced westward through the Finger Lake region and related to the Ashtabula (Lake Escarpment) moraines of the Erie basin in western New York.

The character of the Tully moraine is well displayed in the Tully Lake area, on the main moraine along Route 80 west of Tully Center, and in borrow pits near Gatehouse Pond (Stop 4). Stratified drift comprises most of the exposed area of the Tully moraine. Kame and kettle topography of the moraine proper pass southward into pitted outwash. The Tully Lakes, occupying several of the larger kettles, resulted from burial of isolated masses of stagnant ice beneath outwash carried from the active but essentially stationary ice margin. It is inferred that the ice margin stood for a time at an "advanced Valley Heads position" south of Song Lake. The "main Valley Heads" moraine was formed as the loop north of the Tully Lakes before the stagnating and buried ice of the earlier advance could be completely melted. Similar relationships in Valley

Heads moraine loops in other through valleys suggest similarly oscillating ice margins and justify reference to this complex as the Valley Heads moraine system.

Wherever the Valley Heads moraine loops across a valley divide it is massive. Commonly its proximal (north-facing) margin is steep and abrupt. The moraines are much less impressive as approached from the south, because thick outwash deposits comprise a ramp rising toward the distal margin of the moraine. Similar moraines which, like the Tully moraine, are major heads of outwash, are developed in the Skaneateles and Otisco troughs and in the through valley southwest of Cortland. This latter is unusual in that iceflow was slightly north of east.

Although the Valley Heads moraine is commonly difficult to trace across uplands, an exception is the Tully moraine north of Tully where it crosses Meeker Hill as a belt of prominent constructional topography nearly 2 miles wide. More typical, perhaps, is the character of the moraine along the western border of Cortland County between McLean and Otisco trough. Small loop moraines block the heads of Kinney Gulf and Homer Gulf. In between, the moraine becomes diffuse on upper slopes, though thickened drift and discontinuous patches of stagnant ice topography are scattered on lower slopes. Substantiating evidence for drawing a continuous border to connect the minor valley loops in this area is found in the juxtaposition of glacial striae toward S45W on West Hill as opposed to striae toward S71E on Summer Hill to the west.

Maps

The accompanying field trip guide describes a circuit from Cortland to Marcellus and return. The following quadrangles of the U. S. Geological Survey's $7\frac{1}{2}$-minute topographic map series are essential to understanding of the notes: Cortland, Homer, Sempronius, Otisco Lake, Spafford, Marcellus, Tully and Truxton.

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GLACIAL GEOLOGY AND GEOMORPHOLOGY BETWEEN CORTLAND AND SYRACUSE

Ernest H. Muller, Syracuse University

Total miles	Miles from last point	Route description
0.0	0.0	Leave S.U.N.Y. College at Cortland, 8:30 A.M.
		Proceed south to Tompkins St. (Route 13). Turn right (SE) toward Ithaca. Proceed past Munsons Corners crossing South Cortland outwash plain, rising southwest at about 20 ft./mi. Several streamlets from the till slope to south disappear into this permeable coarse gravel plain.
4.1	4.1	STOP ONE. SOUTH CORTLAND KAMES Active borrow pits in kame complex on south flank of valley expose structure of ice disintegration deposits comprising a linear ridge which is relatively smooth on the distal slope but with massive kame-like aspect to the northwest. Lateral variability of sorting and coarseness is characteristic. The gravels are characterized by crystalline-carbonate-clastic relationship of about 5:15:80 which is representative of through valley drift in this area.
		Continue southwest on Route 13. Outwash plain which is here 120 ft. higher than in Cortland grades southwestward into narrowing kame terrace.
4.6	0.5	Turn right (N) on Webb Rd. toward Fish Hatchery. Descend sharply on ice contact face of kame terrace, into complex of ice disintegration deposits marking stagnant toe of northeastward extending Valley Heads ice tongue.
5.0	0.4	STOP TWO. U.S. FISH HATCHERY Bogs in kettles such as these often contain a consistent palynological record of environmental changes in post-glacial time, but for one reason or another, a significant hiatus commonly exists between deglaciation and first accumulation of datable material.
		Continue north through Gracie across ice disintegration complex.
6.0	1.0	Turn right (E) on Lime Hollow Rd. In .6 mi. cross abandoned meltwater channel cut by stream flowing from melting ice blocks responsible for the Fish Hatchery kettles. Return to kame terrace.
7.6	1.6	Turn left (N) onto Route 13. At "Y-intersection," in .2 mi., bear left on Route 281. Cross Otter Creek. Note lack of postglacial modification of outwash plain.
9.5	1.9	Turn left (W) onto Kinney Gulf Rd. built largely across alluvial fan of Dry Creek. In 1.3 miles Dry Creek and road pass through narrow rock-walled gorge which shortly opens out to form Kinney Gulf. Leave Cortland $7\frac{1}{2}$' quadrangle.

Total miles	Miles from last point	Route description
		Cross southwest corner of Homer quadrangle and enter Sempronius $7\frac{1}{2}$' quadrangle.
13.2	3.7	Rise across outwash to well-defined Valley Heads valley-stopper moraine which forms divide between Dry Creek (Susquehanna drainage) and headwaters of Fall Creek (St. Lawrence drainage).
14.1	0.9	At "t-intersection," turn left onto Route 90. Carney (1909) reported glacial striae to be oriented S45W on summit of West Hill to north of intersection.
15.4	1.3	Turn right (N) on Lake Como Rd. On summit of southeast end of Summer Hill west of route, Carney (1909) reported glacial striae to be oriented S71E, indicating opposing directions of ice flow during late Wisconsin Stage.
16.3	0.9	Turn right (E) onto West Hill Rd. Cross small tributary of Fall Creek which drains Lake Como.
16.6	0.3	Turn left (N) toward Como. To northwest (left ahead) the valley floor opens out as an intermorainal basin, part of which is occupied by Lake Como. Lower slopes enclosing the basin on north and east are marked by strong kame and kettle development.
18.0	1.4	Turn right (E) at Como onto Homer Gulf Rd. (Rte. 41A) and proceed across nose of stagnant ice deposits at drainage divide, before entering Homer Gulf a canyon incised 300 to 500 ft. deep. Post-glacial modification of upper part of the Gulf is minor, and latest gorge-cutting relates to Valley Heads glaciation. Re-enter Homer $7\frac{1}{2}$' quadrangle.
		Query: Is this gulf a product of a single episode of gorge-cutting? Is the moraine position on the divide co-incidental?
21.3	3.3	Turn left (N) onto Rte. 41 proceeding north over outwash and postglacial alluvial fan deposits of Skaneateles trough. In about 2.3 miles cross Valley Heads terminal moraine. Road follows an open, irregular channel cut by meltwater during wasting of stagnant toe of the Skaneateles ice tongue.
25.5	4.2	Proceed north on Rte. 41 through Scott, thence following valley of Grout Brook. Enter Otisco Valley $7\frac{1}{2}$' quadrangle.
27.1	1.6	Stay right at fork, climbing to summit on Ripley Hill Rd.
29.7	2.6	STOP THREE. RIPLEY HILL SUMMIT At elevation of 1986 ft. above sea level Ripley Hill is one of the highest points in Onondaga County and representative of the heavily scoured but relatively unreduced remnants of an essentially accordant pre-glacial summit surface. If pre-glacial summit accordance is accepted, the present departure from summit accordance affords a measure of summit reduction by glacial scour. Elongation

Total miles	Miles from last point	Route description
		of ridges commonly relates to ice-flow. Through valleys, long interpreted as showing a pattern inherited from pre-glacial stream systems, have recently been referred to as "intrusive troughs" implying only minor dependence on inherited pre-glacial controls.
		Proceed north on Ripley Hill Road.
30.9	1.2	Turn left (W) onto Cold Brook Rd.
31.6	0.7	Turn right (N) onto Rte. 41 in Spafford, toward Borodino. Proceed north on dividing ridge between Otisco and Skaneateles troughs. Southeast of Borodino, Tully limestone exposed in roadcuts.
37.1	5.6	Turn right (N) onto Rte. 174 in Borodino. In 1.1 mile, enter Marcellus $7\frac{1}{2}$' quadrangle. Primitive lakes in Skaneateles and Otisco troughs first joined across this col to form Lake Willowdale.
38.3	1.2	Turn right (E), continuing on Rte. 174, descending to level of Otisco Lake.
41.8	3.5	Leave Otisco Lake, continuing north on Rte. 174 through Marietta. Red lake clay in top of valley fill relates to Lake Marietta, a predecessor of Otisco Lake which drained westward into Skaneateles trough.
45.1	3.3	Turn right (E) on Rtes. 20 and 174. Cross valley of Ninemile Creek (Tyler Hollow), then turn left (N) on Rtes. 20 N and 174, proceeding parallel to Ninemile Creek. Roadcuts expose red clay which includes both clay till and lacustrine sediments. Color presumably is due to comminuted red Vernon shale glacially transported from outcrop area about 10 miles north, near Camillus.
47.8	2.3	Tyler Hollow is at this point constricted by a ridge of glacial drift about 200 ft. above level of Ninemile Creek. This plug was largely water-deposited into pro-glacial Lake Marietta, and is to be correlated with a moraine which is traceable across the Skaneateles quadrangle 2 miles north of Skaneateles (probably the Union Springs moraine of Shumaker (1957)). Continue north on Rtes. 20N and 174.
49.8	2.0	Turn right (E) onto Platt Road.
50.0	0.2	Turn left (N) into Marcellus County Park. Lunch stop.
		Leaving County Park, continue east on Platt Road, shortly curving south and bearing left at fork onto Slate Hill Rd. Climbing southeastward on Slate Hill, observe Pumpkin Hollow to the east (left). Cut sharply through Hamilton shale section and floored on Onondaga limestone, this is one of the largest of the cross channels which carried drainage eastward along the plateau margin. Pumpkin Hollow is about .25 mi. wide and as much as 400 ft. deep. Three miles east of Marcellus it widens abruptly to nearly a

Total miles	Miles from last point	Route description
		mile, apparently as a result of confluence with a pre-glacial or interglacial drift-filled gorge from the northwest. . . . Four small marginal meltwater channels notch the nose of Slate Hill to the west.
53.4	3.4	Turn left (E) onto Cherry Valley Turnpike (Rte. 20).
54.5	1.1	Cross Smith Hollow (Navarion Channel). With threshold at 1005 ft. about one mile north of Rte. 20, the Navarino Channel developed as an outflow or overflow channel, bearing meltwater from Pumpkin Hollow (Lake Cedarvale) into Lake Marietta in Otisco trough.
55.0	0.5	Turn right (S) onto Amber Rd. in Navarino. Follow Amber Rd. through two turns as it descends to level of delta deposited into Lake Marietta from Navarino Channel, near 970 ft. above sea level.
57.8	2.8	Cross Amber Brook, incised into the Joshua Channel. With threshold at 1110 ft. the Joshua Channel like the Navarino Channel carried meltwater from the margin of the ice tongue in Onondaga and Cedarvale Valleys. Amber Road is at toe of the 1060 ft. delta built into Lake Newberry. Following a sharp turn westward, the road descends from the 970 ft. or Lake Marietta delta to Heath Grove on the shore of Otisco Lake.
58.5	0.7	Turn left (S) onto Otisco Valley Rd. in Heath Grove.
58.8	0.3	Bear left (SE) onto Oak Hill Rd., ascending east wall of Otisco trough. Lv. Marcellus 7½' quadrangle. Cross corner of Spafford quadrangle and enter Otisco Valley 7½' quadrangle.
71.6	2.8	Continuing southeast on Oak Hill Rd., climb above 1270 feet above sea level, approximately the level of Glacial Lake Otisco, controlled by overflow channel across the Valley Heads moraine in Otisco trough. Just north of Otisco Rd. intersection are several shallow meltwater channels trending southward.
62.8	1.2	Joint Rte. 80, continuing straight toward southeast. Descend southeast into Vesper Valley, a smoothly scoured trough-like glacial furrow occupied by headwaters of Onondaga Creek. With adjacent ridges, including Vesper Hill, an unnamed hill and Dutch Hill, and associated furrows, including Emerson Gulf and the south wall of Rattlesnake Gulf, Vesper Valley displays a nearly geometrical parallelism, suggesting glacial scour of barbed drainage captured by obsequent pre-glacial Onondaga Creek flowing north down the steep plateau border scarp toward the Lake Ontario lowlands.
65.3	2.5	Continue SE on Rte. 80 through Vesper. Cross Onondaga Creek. Enter complex Tully moraine belt where minor ridges of waning Onondaga ice tongue project into Vesper Valley with curvature convex to the northwest. At Fellows Falls just downstream,

Total miles	Miles from last point	Route description
		Onondaga Creek drops with hanging and barbed juncture into Onondaga trough, in this area called Tully Valley. To the left ahead (NE) local relief exceeds 1250 ft. from upland to trough floor on proximal (northern) flank of massive Tully (Valley Heads) moraine. The abrupt proximal border and gently graded distal slope of this moraine is characteristic of valley blocking moraine loops of this system on divides and northward opening valleys of central New York.
		Seismic refraction profiles suggest that the unconsolidated valley fill in mid-trough opposite Fellows Falls may be 400 to 500 ft. thick, with the bedrock floor at 300 to 400 ft. msl. Northward, in the vicinity of Syracuse the bedrock floor of the trough lies below sea level. Southward the rock floor rises to 975 ft. above sea level in the col at Tully Lake. Query: Is the correspondence of moraine and bedrock divide mere coincidence?
66.9	1.6	Bear left, following Rte. 80. Leave west wall of Onondaga trough exposing Moscow shale in roadcut. Proceed east onto Tully moraine, parallel to steep slope marking the proximal border of moraine. Kettles on both sides of road.
67.6	0.7	STOP FOUR. GATEHOUSE POND AND SOLVAY GRAVEL PIT Steep-walled gravel pit exposes materials composing major part of Tully moraine, showing it to be largely a product of outwash deposition from a stationary to narrowly oscillating ice margin. Exotic component in this through valley gravel is high with crystalline-carbonate-clastic ratios on the order of 10:40:50. The "bright" character of the gravels results from proximity to carbonate sources, attrition of diluting shale fraction from the lake plain, and effectiveness of glacial transport in a major through valley.
		Turn right (S) and proceed on Gatehouse Rd. through kame and kettle complex of the Tully moraine complex. Southward the kames diminish in relief and grade into kame terrace and pitted outwash plain. Stagnant ice of the Tully ice tongue extended about two miles south of this route to an "advance Valley Heads" position, before receding three miles to the massive "main Valley Heads" position to Stop Four.
68.9	1.3	Turn left (E) onto Lake Rd. passing between Tully Lake and (Tully) Green Lake. Character of outwash gravels is exposed in borrow pit opposite (south) of Green Lake. This outwash plain, augmented by massive outwash fans from Otisco and Skaneateles troughs extends southward nearly 20 miles to Cortland. Both the outwash surface and the bedrock floor of the trough show more or less consistent southward gradient.
70.3	1.4	Near Tully Center, pass under Interstate Rte. 81, cross Rte. 281 and join Rte. 11 along edge of outwash plain toward Tully.

Total miles	Miles from last point	Route description
71.0	0.7	Continue east through Tully, on Rte. 80 toward Apulia. About .5 mile east of Tully, cross low, smoothed valley choker moraine, convex eastward. This moraine may correlate with the "advance Valley Heads" position defined in Tully Valley by the outer border of the Tully Lakes area. If so, the smoothed nature of this ridge is puzzling, but may relate to impounding at the ice margin.
72.7	1.7	Continuing eastward on Rte. 80, near Markham Hollow Rd. enter Valley Heads moraine complex of Butternut trough. Proximal margin of moraine is less sharply defined than in Tully Valley. "Main Valley Heads" position is south of Apulia Station.
74.5	1.8	Turn right (S) onto Rte. 91 in Apulia. The Apulia-Fabius trough extends eastward for several miles. Although segmented by drift deposits that define the heads of several drainage basins, this valley has the continuity suggestive of origin as part of a south-westward draining pre-glacial stream system.
75.1	0.6	Cross moraine ridge. Toward axis of north-south through valley this ridge separates into three small but well-defined ridges marking recession of "advance Valley Heads" ice. The road follows a marginal meltwater channel between moraine ridge and valley wall.
76.4	1.3	Meltwater channel widens, opening onto outwash plain upon which shallow Labrador Pond is located. Valley floor is less than .5 mile wide between 750-ft. walls which converge southward as though toward a bedrock col. Labrador Pond, however drains south-ward by Labrador Creek on gradient developed by outwash deposition. Query: How does the transverse relationship of the Apulia-Fabius trough and the Butternut-Labrador trough clarify the relative importance of inherited valley system as opposed to glacier scour in determining the through valley pattern of this part of the plateau?
79.1	2.7	Cross Shackham Brook. State reforestation area and experimental drainage basin to east of route. Kame complex developed in valley wall re-entrant where Shackham Brook debouches into Labrador trough. Leave Tully, enter Truxton $7\frac{1}{2}$' quadrangle.
80.9	1.8	Pass Labrador Mtn. Ski resort.
82.1	1.2	STOP FIVE. TRUXTON TOWN HIGHWAY DEPARTMENT BORROW PIT Stratified sand and silt, with foreset beds and collapse structure. Dominance of shale in gravel, with small per cent of crystallines and carbonates indicates dilution by uptake of local rock material. Rapid attrition of such material with fluvio-glacial sorting might within a few miles of through valley transportation "brighten" even this drab gravel, giving it a Binghamton-type lithology.
83.1	1.0	Turn right (") onto Rte. 13 in Truxton, birthplace of J.J.McGraw, for 30 years manager of the New York Giants.

Total miles	Miles from last point	Route description
88.5	5.4	Continue southwest through East Homer settled by Revolutionary War veteran John Albright in 1827. Route 13 lies along valley of East Branch Tioughnioga Creek, apparently a major tributary of the pre-glacial drainage line inferred to have extended west from Cortland toward Cayuga trough.
90.2	1.7	Continue southwest past East River, on Rte. 13 toward Cortland. Leave Truxton, enter Homer 7½' quadrangle. Coarse kame terrace gravels exposed in several pits in next three miles. Esker parallels Rte. 13 south of Light House Rd. where John Miller built first cabin in 1792.
92.4	2.2	Leave Homer, enter Cortland 7½' quadrangle.
93.8	1.4	Pass under Interstate Rte. 81 and cross West Branch Tioughnioga Creek. Draining the Tully-Homer-Cortland trough, this creek joins East Branch Tioughnioga Creek .5 mile east. The combined discharge drains south in a through valley with converging walls indicative of a pre-glacial divide a few miles south of Cortland.
		Bear right onto Clinton Street.
94.6	0.8	Turn left onto Main Street. A well drilled for Brockway Motor Co. penetrated 180 ft. of stratified drift without reaching bedrock.
94.8	0.2	Turn right (W) on Court Street and return to campus, S.U.N.Y. College at Cortland.

PALEONTOLOGY AND STRATIGRAPHY OF THE CORTLAND-SYRACUSE-ITHACA AREA

W. Graham Heaslip, S. U. C. C.

The Silurian and Devonian history is unfolded in the rock layers which underlie this region, even though these geologic periods of time went by hundreds of millions of years ago in Central New York.

The widespread and consistent nature of some of the rock strata (e.g. Onondaga Limestone) is contrasted to the limited distribution of certain other beds (e.g. the Oriskany Sandstone, or the changing lithology of certain time-rock units, as in the Hamilton (Middle Devonian) beds which grade from coarse silts and sands in the Syracuse region to much finer clays and even limestones in the Lake Cayuga area. Also evident is the transition from fine sediments at the beginning of Middle Devonian deposition through coarser and coarser sands of Late Devonian, and likewise, from marine to deltaic deposition. All of these observations evident in the various trip stops have a definite relationship to the building of the ancestral Appalachian Mountain system.

Also evident is the correlation between lithology (or "lithofacies") with associated fossil types and environment of deposition in the seas which covered New York during the Silurian and Devonian Periods. Thus, black fine grained sediments indicate stagnant conditions of low oxygenation; gypsum and salt ("evaporite") beds indicate restricted shallow deposition under arid climatic conditions. Other lithofacies also have important significance as an examination of the rocks in the field will establish.

Silurian System

The rocks of the Silurian System in the field trip area belong to the Salina Group, so named for the bedded salt which occurs in the Syracuse Shale. This formation crops out to the north of the trip route, but the beds, like the entire sedimentary sequence of the region, dip to the south

about 50 feet per mile, and are at a depth of about 1800 feet near the south end of Cayuga Lake. Here, the salt is mined and brought to the surface through pipes in solution and as rock salt by hoppers in shafts drilled into the rock. The overlying Camillus Shale as well as the Syracuse, contains gypsum which is a valuable economic material in the building industry and is also mined in the outcrop belt to the north. Both salt (the mineral halite) and gypsum are precipitates from highly concentrated brine, and the obvious interpretation is that central New York was the site of a vast evaporating pan in which sea water was continually being poured from surrounding shallow marine areas and evaporated in an arid climate. The hypersalinity of the shallow marine waters of the Late Silurian time is also indicated by the absence of all but a few hardy animal groups preserved as fossils in the shales. Only a few small clams, snails and bivalved crustaceans called ostracodes are scattered through the Camillus beds; the Syracuse Formation is barren of fossils.

The overlying Bertie Formation, consisting of beds of dolostone and gypsiferous shale, also testify to the highly saline water. There are also sparsely fossiliferous, and also contain a peculiar group of arachnoids called Eurypterids, or "sea scorpions" which seem to be associated in the fossil record mainly with dolomites. This rock type may represent carbonate deposition under conditions of high salinity.

Devonian System

The rocks of the Devonian System have been known for over one hundred years in the region of central New York and the Finger Lakes, and classic fossil-collecting localities were visited in the 1800's by Lardner Vanuxem, James Hall and other pioneers of New York geology.

Lower Devonian Series

The rocks of the Lower Devonian, like the latest Silurian beds, are carbonates, and also contain dolomite (especially the Cobleskill and parts of the Manlius Formation). However, there is also much limestone, perhaps indicating a return to sea water of normal salinity. The rocks of Early Devonian time are also much more highly fossiliferous than those of the Silurian, and invertebrate fossils abound in some beds. These include corals, bryozoa, ostracodes, crinoids and other normal salinity groups.

Much more limited in distribution than the underlying carbonates, is the Oriskany Sandstone, a relatively pure quartz sand which apparently accumulated in shallow water very near to the shoreline of the Devonian Sea. This formation is abundantly fossiliferous, but the porous and permeable nature of the sandstone has allowed ground water to leach out the calcium carbonate of the brachiopod and snail shells and these are represented only by impressions or molds in the sand.

Middle Devonian Series

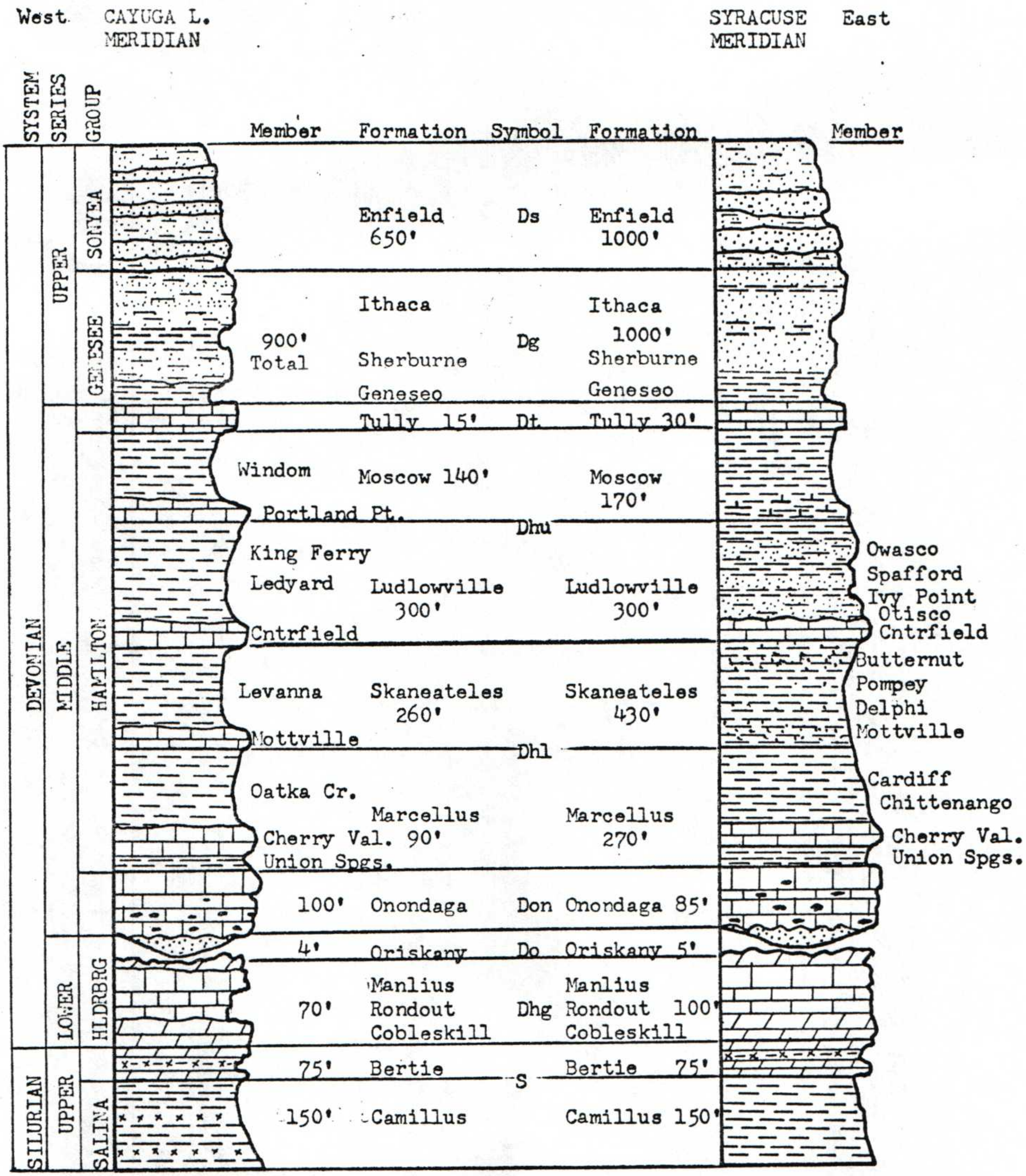
Middle Devonian deposition began with the Onondaga Limestone which, in most areas of outcrop in the state, is on the order of 100 feet in thickness. This is one of the most widespread of all the rock units in the eastern United States, cropping out in a continuous belt from the Hudson Valley, Albany, Syracuse, Buffalo and the Great Lakes region to the west. It is also found to the south in the Appalachians and the lowland states to the west. Its rich fauna of fossil corals, trilobites, brachiopods and crinoids testifies to the benign conditions of deposition in a vast shallow sea which covered much of the eastern United States during that time. One of its characteristics is the high percentage of silica in the form of beds and nodules of chert (flint) which weather at a much slower rate than the enclosing limestone and project outward

from a deeply weathered surface. This formation, despite being a carbonate rock, is highly resistant to weathering and forms a persistent topographic scarp through northern New York and the Great Lakes region. The limestone was extensively quarried for building stone many years ago and many of the older houses of the region are built of the Onondaga. Many small, abandoned quarries dot the landscape in its band of outcrop. It is still extensively quarried for cement and road metal, especially near Buffalo, and Syracuse and the region south of Albany.

The clear seas of Onondaga time which resulted in the precipitation of beds of calcium carbonate were soon clouded by great quantities of mud, silt and sand following Onondaga deposition. The overlying succession of Hamilton formations consist mainly of shales, muddy siltstones and sandstones, with only occasional thin beds of limestone. Many of the shales are black in color and contain only a very sparse fauna of cephalopods, small pteropods (swimmers) and small brachiopods which are thought to have been attached to floating seaweed, as well as fragments of land plants. No fossil groups known to have lived directly on the bottom are known, and the black color (caused by unoxidized carbon) and nodules of iron sulfide (marcasite) indicate the original environment to have been stagnant water with a muck bottom reeking of hydrogen sulfide and obviously unfit for bottom dwellers.

On the other hand, some of the coarser sediments (siltstones and sandstones) contain vast numbers of benthonic invertebrates such as brachiopods, corals, crinoids, etc., indicating that the bottom was well oxygenated and suitable for life.

It is apparent from the stratigraphic columns that the Hamilton formations thin from the Syracuse meridian to Cayuga Lake. It is also apparent that the Syracuse section is much coarser in grain size than the rocks



Simplified time-stratigraphic chart showing major rock units in the eastern Finger Lakes region, comparing lithologies and thicknesses of units between the meridian running through Syracuse on the east and that through Cayuga Lake on the west. No scale in time or thickness implied in vertical height on chart.

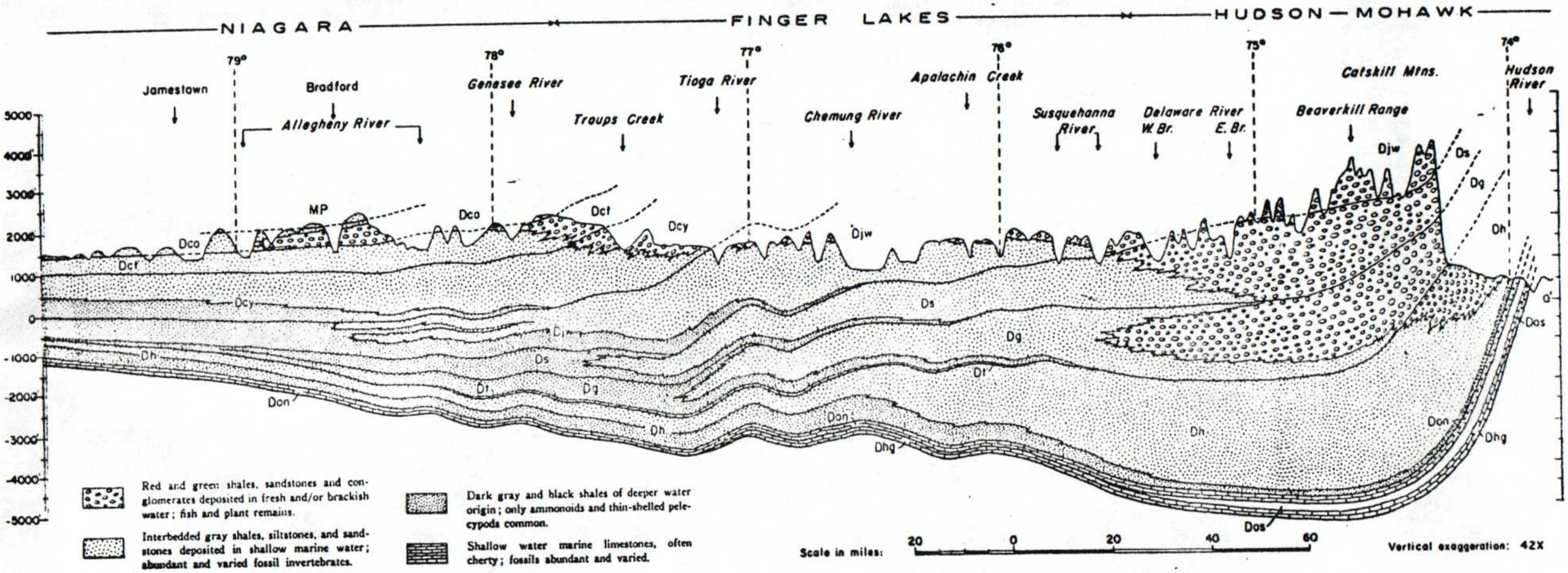
of the Cayuga section and that the individual formations (or better, time-rock units) grade from silts and sands on the east to fine muds and thin limestone beds to the west. The implications here are that the source of the clastics was toward the east and, based on this sort of evidence, we know that a mountain chain (the Acadian or Shickshockian Range) was being elevated along what is now the Appalachian belt.

The Tully Limestone is the last carbonate unit in this region and its inclusion in a dominantly clastic depositional sequence indicates that, for a short period of time, the mountain chain has ceased to rise and that the supply of clastics became limited.

Upper Devonian Series

The sediments of the Upper Devonian, however, show a return to clastic deposition and the rocks of the Genesee Group begin with the fine shales of the Geneseo Formation, but rapidly become coarser in texture in the succeeding Sherburne and Ithaca Formations. These still contain marine fossils as well as increasing quantities of land plant remains. The overlying Enfield Formation (Sonyea Group) becomes coarser in texture and contains only sparsely distributed marine fossils. Moreover, it contains abundant evidence of having been deposited on a delta such as cross-bedding and the linear grooves on bedding plane surfaces which are filled by sediment from the overlying bed (flute casts, etc.) indicating very near shore shoal conditions in which floating branches were dragged over the depositional surface by tidal currents before being swept out to deeper water.

The developments of the Middle and Late Devonian all point to increasing quantities of clastic sediment which was weathered and transported by streams from the eroding Acadian Mountains to the east and being poured into a gradually filling marine basin to the west. The structure formed by these clastics is known as the "Catskill Delta" from exposures of red



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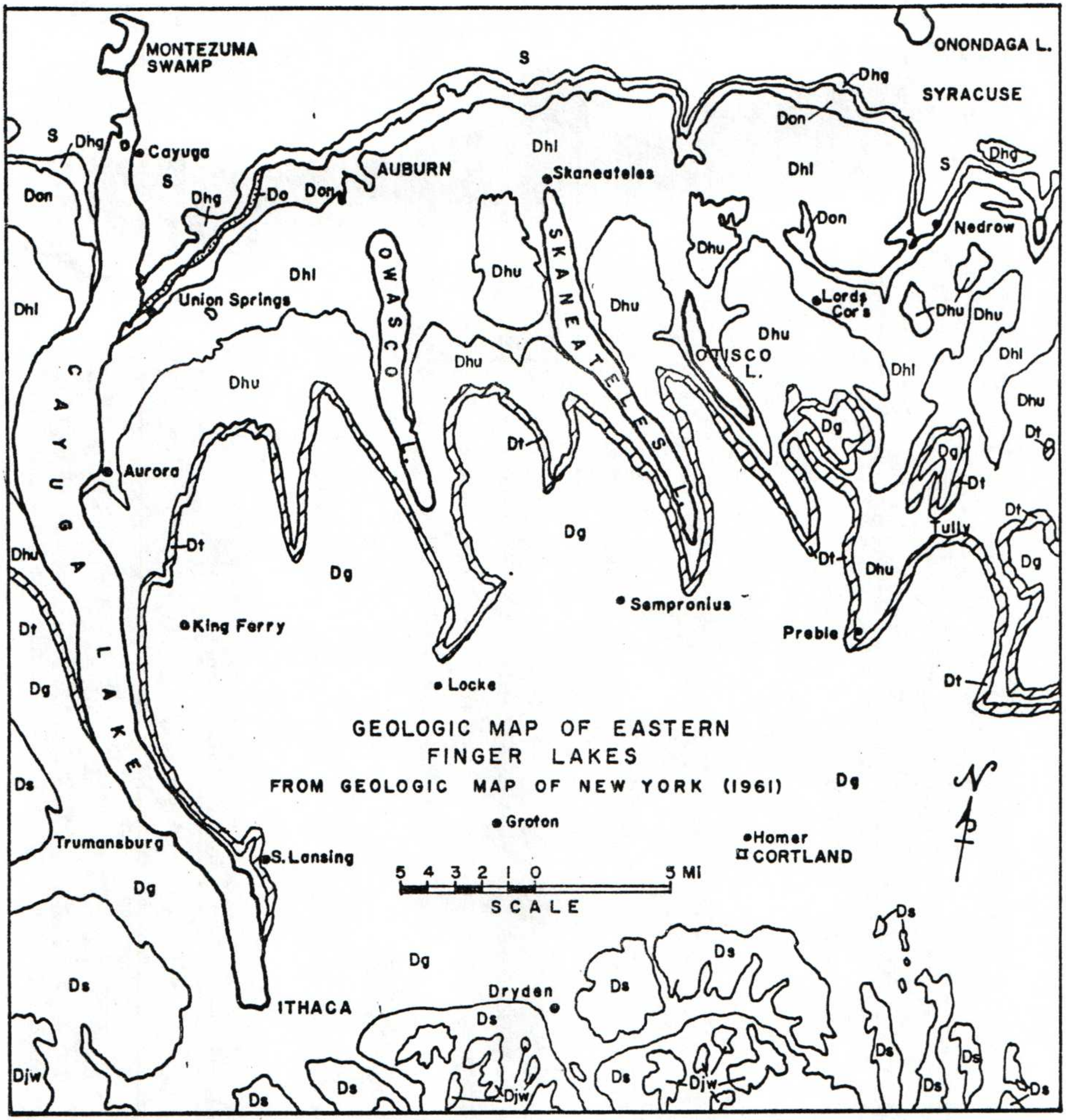
CROSS SECTION OF DEVONIAN ALONG NEW YORK-PENNSYLVANIA BORDER

sandstones and conglomerates of the same age in the Catskill Mountain region of eastern New York. The rocks of that region contain only fossils of land plants and fresh water clams. The red coloration in the sediments likewise indicates subaerial conditions of high oxidation and probable deposition on a vast alluvial plain.

Younger beds of the Devonian have been stripped away from the Finger Lakes region by erosion, but in southern and western New York, where they are found, they relate a continuation of the same building of the delta through the end of the Devonian Period. Only small patches of later Palozoic clastics are found in the southern part of the state, and the rest of the geologic record up to the Pleistocene is obscure.



LEGEND

UPPER DEVONIAN	Djw	Java, West Falls Group	MIDDLE DEVONIAN	Dhl	Lower Hamilton Group
	Ds	Sonyea Group		Don	Onondaga Limestone
	Dg	Genesee Group	LOWER DEVONIAN	Do	Oriskany Sandstone
MIDDLE DEVONIAN	Dt	Tully Limestone		Dha	Helderberg Group
	Dhu	Upper Hamilton Group	SILURIAN	S	Upper Silurian Rocks

PALEONTOLOGY AND STRATIGRAPHY OF THE CORTLAND-SYRACUSE-ITHACA AREA

W. Graham Heaslip, S.U.C.C.

Total Miles	Miles from last point	Route Description
0		START CORTLAND COLLEGE CAMPUS, CAMPUS SCHOOL PARKING LOT.
		Leave parking lot, proceed east along Prospect Terrace to left turn on Graham Avenue, north on Graham Avenue past Administration building to Groton Avenue. Turn east on Groton, continuing past Main Street on Clinton Avenue.
2.0	2.0	Turn north on Route 13 to Interstate 81 entrance about .5 mile after turn. Proceed north on Route 81 through Cortland and Homer. En route, note fresh exposures of alternating shaly and silty facies of Ithaca Formation to right of bus.
		Various glacial features observed in Tioughnioga River valley as proceed north. About 3 miles north of Homer, Little York, Green and Goodale Lakes are glacial kettles. Mt. Toppin, just north of Little York is a truncated spur. Just beyond is Otisco valley on the west which was originally a large tributary valley to the ancestral Tioughnioga, but was choked with glacial outwash and now drains north into deepened Otisco Lake. Just beyond this is the village of Preble. Note the oversteepened slopes on the truncated spur to the west of the town.
16.2	14.2	Village of Tully Center. Roadside outcrops of Moscow Shale to east along old Route 11.
		The Tully lakes, just to the south of Tully Center, are glacial kettles, and the flat-floored valley to the south is a pitted outwash plain. Just to the north of Tully Center we cross the Valley Heads recessional moraine, a ridge of glacial debris which blocked the Tully valley as the latest (Wisconsinan) glacier retreated to the north. Note the deep valley north of the moraine, which would seem to indicate a rather rapid retreat of the ice sheet after its pause at Tully Center. Between the margin of the retreating glacier to the north and the moraine to the south, the glacial meltwaters were impounded in a deep proglacial lake (Lake Onondaga) which was drained only after the ice sheet retreated to the Ontario Lake Plain to the north of Syracuse.
22.7	6.5	Village of Lafayette, Route 20 overpass.
27.7	5.0	Exit from Route 81 to Route 11 at Nedrow, proceeding .2 mile to Kennedy Road.
27.9	0.2	Turn right on Kennedy Road and park at shoulder.
		STOP 1. Exposures on new Route 81 of uppermost Onondaga limestone overlain by Union Springs Shale and Cherry Valley Limestone. Note thrust fault in small gully at roadside.

Total Miles	Miles from last point	Route Description
		Walk north on Route 11, view entire section of Onondaga underlain by limestones of the Manlius Formation. Note that Oriskany Sandstone missing here. Indian Reservation quarry across road is type locality for Onondaga Ls.
		Continue north on Rt. 11 to sharp left just past sawmill in Nedrow.
28.8	0.9	Left turn on Route 11A southwest through Indian Reservation.
30.3	1.5	Turn right just past school in Indian village.
31.0	0.7	Pass quarry in terrace sand on right of road.
31.2	0.2	Left turn on Route 80 (south).
31.8	0.6	Bear right at fork, follow Route 80.
32.3	0.5	Left turn, follow Route 80.
32.7	0.4	Bear right past South Onondaga School.
33.2	0.5	Turn left, follow Route 80.
35.0	1.8	Cross Route 20 at Lords Corners.
35.2	0.2	Continue up Lords Hill on Route 80 for .2 Mile.
		STOP 2. Staghorn Point biostrome in Otisco Shale. 20 foot coral beds containing several species of Devonian horn corals, absence of other marine fossil groups. Widespread over central New York.
35.8	0.6	Continue south on Route 80, roadside exposure of Ivy Point Siltstone.
36.9	1.1	Turn left on Kingsley Road.
38.1	1.2	Proceed to roadside exposure of Tully Limestone.
		STOP 3. Roadside exposure on south and abandoned quarry on north of road in Tully Limestone. Some trilobites obtained here. Walk along road about .2 mile to roadcut in upper Moscow shale at intersection with Hitchings Road. Note especially lithologic character of Moscow at this point. Some fossils.
39.3	1.2	Return to Route 80, turn right (north).
41.4	2.1	Proceed back to Route 20, turn left (west).
		To the north (right) of the road, Onondaga Valley flood control project by U. S. Army Engineers. Total bust, not enough water in valley to justify the concrete dam, a monument to waste.

Total Miles	Miles from last point	Route Description
44.9	3.5	Village of Navarino.
45.3	0.4	Smith Hollow Pond to left (south), miniature "finger lake," drains south into Otisco Lake.
47.8	2.5	Route 174 joins from right (north).
48.0	0.2	Cross Ninemile Creek which occupies glacially enlarged stream valley and drains to south into deepened Otisco Lake.
48.3	0.3	Route 174 goes to south. Note lake deposits of fine silt and clay on right bank of road.
49.0	0.7	Village of Clintonville.
50.4	1.4	Intersection with Route 174 (Fisher Road). Look right to gravel quarry in outwash. One of characteristic lithologies in large cobbles is Onondaga Limestone.
51.5	1.1	Continue west on Route 20. Skaneateles limits. Proceeding through center of Skaneateles, note excellent view south along trough of Skaneateles Lake. Typical Finger Lake which occupies glacially enlarged and deepened old river valley.
54.0	2.5	Cayuga County Line. Proceed through low drumlin topography oriented NNW-SSE.
56.7	2.7	Quarry to right (north) of road in outwash sands and gravels (J. W. Dougherty Construction Corp.). Fine grain size, good sorting and cross-bedding are evident in this deposit.
58.2	1.5	Proceed west on Route 20 to Auburn City limits.
58.8	0.6	Bear left on Genesee Street (Route 20).
59.1	0.3	Right on James Street, follow Route 20.
59.2	0.1	Left on Clark Street, follow Route 20.
60.1	0.9	Continue on Route 20 out of Auburn, join Route 5.
60.5	0.4	Auburn City Limits.
61.3	0.8	Roadside quarry to left (south) in basal Onondaga Limestone.
63.5	2.2	Cross railroad track. Drumlin topography, long axes perpendicular to road for about 2 miles.
67.2	3.7	Route 20 turns north, parallels long axis of drumlin.
68.9	1.7	Intersection with Route 90.

Total Miles	Miles from last point	Route Description
69.2	0.3	Cross bridge over Cayuga and Seneca Canal, turn right (north) into Montezuma National Wildlife Refuge at sign.
69.9	0.7	Continue north on dirt road past ranger station, stop at view of swamp.
		STOP 4. Lunch Stop.
		Montezuma Swamp. Remnant of proglacial Lake Iroquois which originally covered the entire Ontario Lake Plain as glacier melted northward. Sedimentary sequence found in "muck farm" region on lake plain shows blue clay (deep water) succeeded by marl (shallow water) and peat (swamp) on top testifying to the gradual drying up of the lake after the glaciers had melted far to the north and the region had rebounded to some extent. "Fossil" fresh water mollusks collected from the lake sand near the shore are the same as those found in the marl and peat elsewhere.
70.6	0.7	Return to Route 20, turn left.
71.1	0.5	Cross bridge to Route 90, turn right (south).
71.2	0.1	Small outcrop on left roadside of Fiddlers Green Dolomite (Bertie Formation).
73.6	2.4	Proceed south on Route 90 to fork in road, bear right, leave Rt. 90.
73.9	0.3	Proceed along Lake Road to outcrop in rear of Beacon Feed Company plant in Cayuga.
		STOP 5. Camillus Shale with bedded gypsum, Salina Group, Late Silurian. "Evaporite" deposit of Late Silurian in central New York. Syracuse Shale underlying this has thick beds of halite. Both are testimony to the "drying pan" conditions of the isolated sea under arid climatic conditions which existed here during that time. The salt is mined at depth near the south end of Cayuga Lake.
74.5	0.6	Follow Lake Road through Cayuga, rejoin Rt. 90.
78.4	3.9	Proceed south on Route 90 to Route 326, turn left (west).
78.9	0.5	Town quarry in Manlius Limestone on left.
79.9	1.0	Route 326 bears left at Powers Corner.
80.5	0.6	Continue north to left fork at Weed Road, park by barn on right of road.

Total Miles	Miles from last point	Route Description
		STOP 6. Walk about .5 mile along pasture road to west into Yawgers Woods. About 4 feet of Oriskany Sandstone lie on Manlius Limestone and are overlain by about a foot of basal Onondaga Limestone (further back in the woods, toward the road). This relationship not evident at Stop 1, Oriskany missing there. This is one of the classic American Devonian collecting localities and in 1810, DeWitt Clinton described the locality and commented on the fossils. In 1820, Benjamin Silliman sent fossils from this site to the famous French paleontologist, Alexandre Brongniart, who was unable to name the, but correctly correlated this sandstone with Devonian sandstones in Europe.
82.6	2.1	Return to Route 29 along 326, turn left (south).
84.6	2.0	Pass through village of Union Springs, quarry in upper Onondaga Limestone south of village. (Union Springs Shale overlies Onondaga in this quarry. Note gray-weathering Onondaga in some old houses en route).
85.6	1.0	Cross Great Gully.
87.0	1.4	Kings Corners Road and creek with Mottville Limestone to left.
87.9	0.9	Levanna Shale outcrop, both sides of road.
88.9	1.0	Village of Levanna.
92.8	3.9	Pass through village of Aurora, Wells College on left at south end of town.
93.2	0.4	Prospect Corners Road, turn left.
94.0	0.8	Prospect Corners, turn right on Moonshine Road.
94.7	0.7	Take right fork in road, continue to bridge over Paynes Creek.
		STOP 7. Moonshine Falls. Walk downstream on path just north of bridge to falls. Falls formed by Portland Point Limestone (equivalent of lower Moscow) underlain by weak King Ferry Shale (equivalent of siltstones seen at Lords Hill). Limestone overlain by black Windom shale (equivalent of Moscow seen at Stop 3). Note lithologic differences as well as faunal differences from the eastern localities.
		Continue over bridge to right turn in road.
95.1	0.4	Intersection with Route 90, turn left (south).
100.6	5.4	Bear left on Rt. 90 at Jump Corners.
101.7	1.1	Turn right (south) on Route 34B at King Ferry.

Total Miles	Miles from last point	Route Description
105.8	4.1	Village of Lake Ridge.
111.1	5.3	Turnoff to Ludlowville on left. Remain on 34B.
113.2	2.1	Continue on 34B to Portland Point Road, turn right.
113.6	0.4	Portland Point Road to quarry entrance of Cayuga Crushed Stone Company, turn left.
114.3	0.7	Proceed about .7 mile into main quarry.
		STOP 8. Portland Point Quarry. About 16 feet of Tully Limestone underlain by Windom (Moscow) Shale in quarry floor and overlain by Geneseo black Shale (about 15 feet). Boundary between Middle and Late Devonian at Tully-Geneseo contact. Note recurrence of black shale facies. What does this mean in terms of depth, circulation? Why unfossiliferous?
		At Portland Point, the Silurian salt is mined at a depth of about 1800 feet by room and pillar methods. To the north, at Meyers Point, salt is pumped from the subsurface in the form of brine. At Portland Point is also located a cement plant which used the limestone quarried here.
115.4	1.1	Return to Route 34B, turn right (south).
116.1	0.7	Continue on 34B to South Lansing, left on Rt. 34.
123.5	7.4	Routes 34 and 13 into Ithaca, turn right on W. Seneca Street (follow Rt. 13). (W. Seneca St.).
123.7	0.2	Left on South Albany Street (follow Rt. 13).
125.9	2.2	Continue on Route 13 to Buttermilk Falls State Park entrance. Turn into parking lot.
		STOP 9. Buttermilk Falls. Almost entire thickness of Ithaca formation exposed here starting at lower falls and going upstream. Lower member shaly (Renwick) become more flaggy in upper members (Cascadilla, Triphammer). Youthful stream features (potholes, etc.) present upstream. Note that lithologies here compare to Middle Devonian lithologies to east (Owasco, Moscow, etc.). Sediments become coarser as we go higher in the Late Devonian, indicating rising land mass to east.
128.0	2.1	Turn right (north) from entrance to park back toward Ithaca, bear left on Albany Street, turn right on Green Street, follow 79, 366.
128.8	0.8	Continue up East State Street Hill, bear left on Route 366 after 79 diverges to right.

Total Miles	Miles from last point	Route Description
129.1	0.3	Bear right on Rt. 393 (Mitchell St.) as Rt. 366 bears left.
132.0	2.9	Continue out of Ithaca on Ellis Hollow Road to Quarry Road, turn right (south).
133.2	1.2	Turn right at Quarry entrance.
		STOP 10. Finger Lakes Stone Company quarry in Enfield Formation. Flagstones, some shales, dominantly non-marine, cross-bedded, with flute-casts, various sole marks. What does this indicate about the source area of the sediments during the Late Devonian? Stone from this quarry widely used as flag and facing stone on Cornell and Cortland Campuses and elsewhere in New York State.
134.1	0.9	Return south on Quarry Road, cross Cascadilla Creek.
135.5	1.4	Continue on Monkey Run Road to Route 366, turn right.
136.6	1.1	Bear right on Route 13 just west of Niagara-Mohawk Power Station.
142.8	6.2	Town of Dryden, left turn on Route 13.
145.8	3.0	Roadside exposures in Ithaca beds.
148.3	2.5	Gravel quarry to right of road in esker (?).
149.5	1.0	Bear right on Route 13 at light.
150.0	0.5	Outcrop of Ithaca beds at trailer park on right.
152.2	2.2	Tompkins Street (Rt. 13) to Broadway, turn left.
152.5	0.2	Broadway to Prospect Terrace, turn right past dormitories to Campus School Parking Lot.
		END TRIP.